Measuring Agility

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Previously

- 21st Century mission challenges are Complex Endeavors with a complex mission, a complex environment, and a complex self

- There is no "one size fits all solution" to accomplishing the functions that our community associates with Command and Control; different approaches are appropriate for different situations

- The Command and Control (management, governance) of an entity is different from that of efforts to focus a Collective (complex self) and converge on a set of shared objectives

- In Complex Endeavors, the relationship between the two is critical

- Agility is not just a desirable capability, it is an Imperative

- More network-enabled approaches are more Agile

Agenda

- What do you mean by Agility?
- How do you apply the concept of Agility to C2/M/G/F&C?

- How can we visualize and measure Agility?

- Does the evidence support the following assertions?

  – Different approaches work best in different situations

  – More networked-enabled Approaches are more Agile

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- **Is there a relationship between Cybersecurity and Agility?**
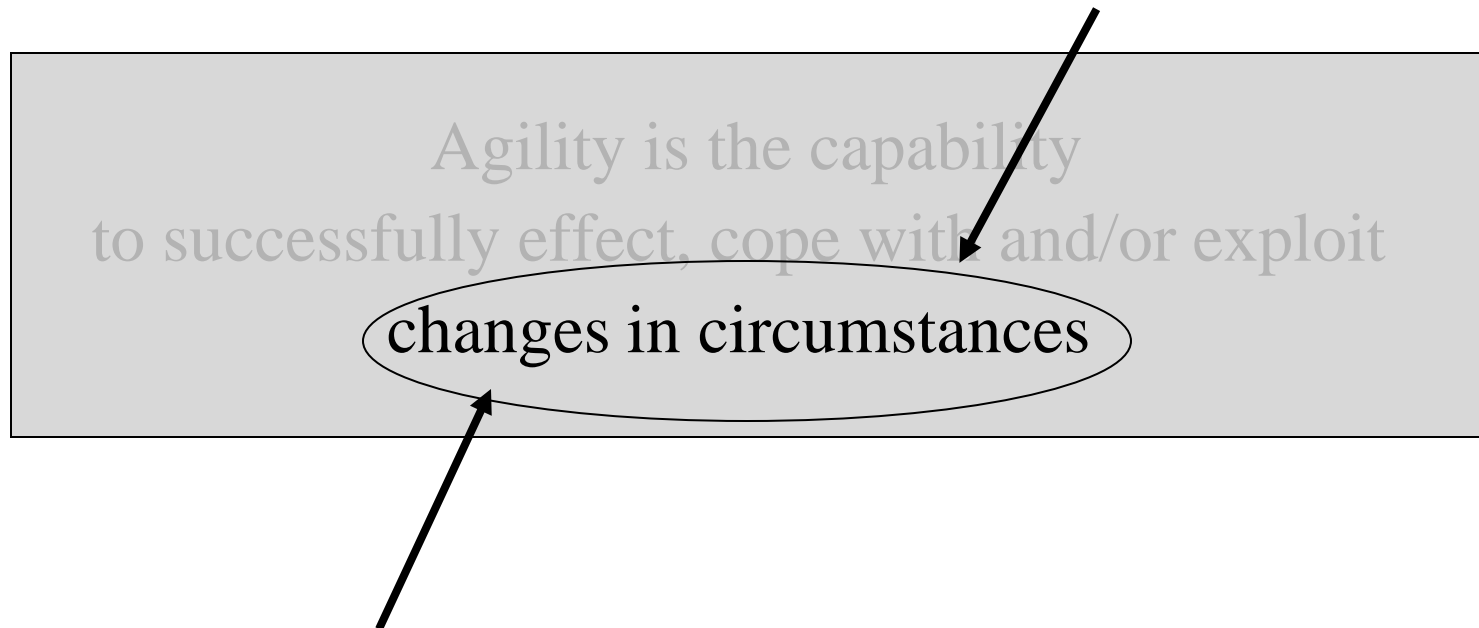
Acknowledgements

- SAS-085 Group Members

- ELICIT Team

What is Agility?

Agility is the capability
to successfully effect, cope with and/or exploit
changes in circumstances

What is Agility?

- relevant set = Endeavor Space

Agility is the capability
to successfully effect, cope with and/or exploit
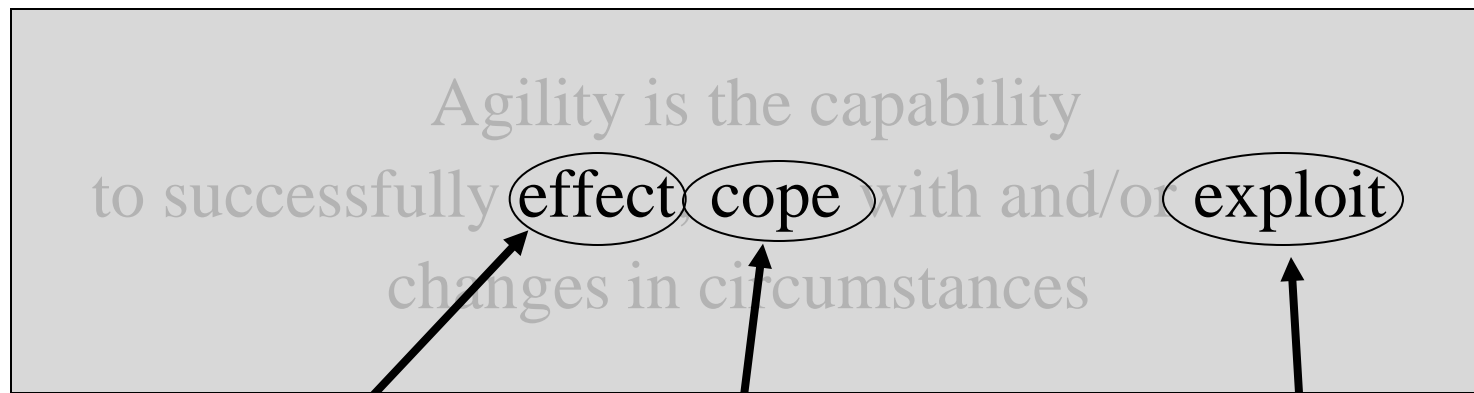
changes in circumstances

- The concept of Agility does not apply to a stable situation
- Changes may be external to self (e.g. regime change, permissive to hostile) or changes to self (e.g. a new coalition partner, loss of capability)

What is Agility?

Agility is the capability
to anticipate, effect, cope with and/or exploit
changes in circumstances

successfully

within acceptable bounds of performance
(e.g. effectiveness, efficiency, risk)

What is Agility?

Agility is the capability
to successfully effect, cope with and/or exploit
changes in circumstances

create an opportunity by changing an aspect of circumstances you can influence

anticipate or respond to an event that would otherwise have adverse consequences

take advantage of an opportunity to improve effectiveness, efficiency reduce risk

Manifest v. Potential Agility

- As defined, the Agility (or a lack of) can only be directly observed if, and when, a change of significance takes place.

- Some events that are possible, even probable, may not take place during a particular endeavor.

- It is important that entities do not confine their assessments of their Agility to what has actually occurred.

- There are two ways to assess an Entity's Potential Agility

  - Test predicted Agility using experiments and exploratory analysis
  – Develop a Model of Potential Agility based on indicants

Agenda

- What do you mean by Agility?

- **How does one apply the concept of Agility to C2/M/G/F&C?**

- How can we visualize and measure Agility?

- Does the evidence support the following assertions?

  – Different approaches work best in different situations

  – More Networked Enabled Approaches are more Agile

- Is there a relationship between Cybersecurity and Agility?

C2/M/G/F&C Agility

- There are _many ways_ to accomplish the functions our community associates with Command and Control; the most appropriate approach will be a function of the nature of the endeavor and the prevailing circumstances.
- The set of relevant missions and circumstances forms an Endeavor Space; the set of possible approaches forms an Approach Space.
- The Agility of a given Approach is related to the area of Endeavor Space where the Approach can be successful.
- C2/M/G/F&C Agility is the ability to move around in the Approach Space in response to changing missions and circumstances
- Agile systems and processes are required

Agenda

- What do you mean by Agility?

- How does one apply the concept of Agility to C2/M/G/F&C?

- **How can we visualize and measure Agility?**

- Does the evidence support the following assertions?

  - Different approaches work best in different situations

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- Is there a relationship between Cybersecurity and Agility?

Approach Agility Map

An Agility Map is a projection of performance onto Endeavor Space

e.g. Region where a given Approach can operate successfully
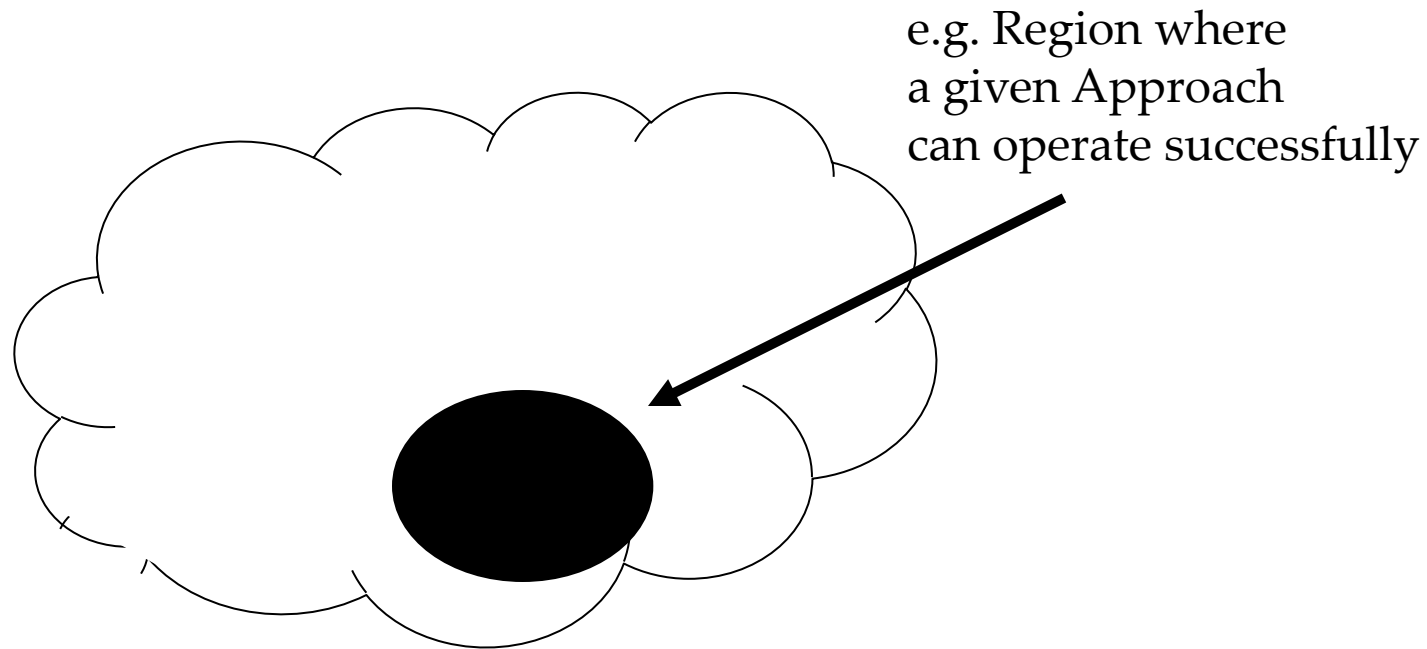
Endeavor Space is a multi-dimensional space consisting of regions that correspond to different endeavor characteristics and conditions
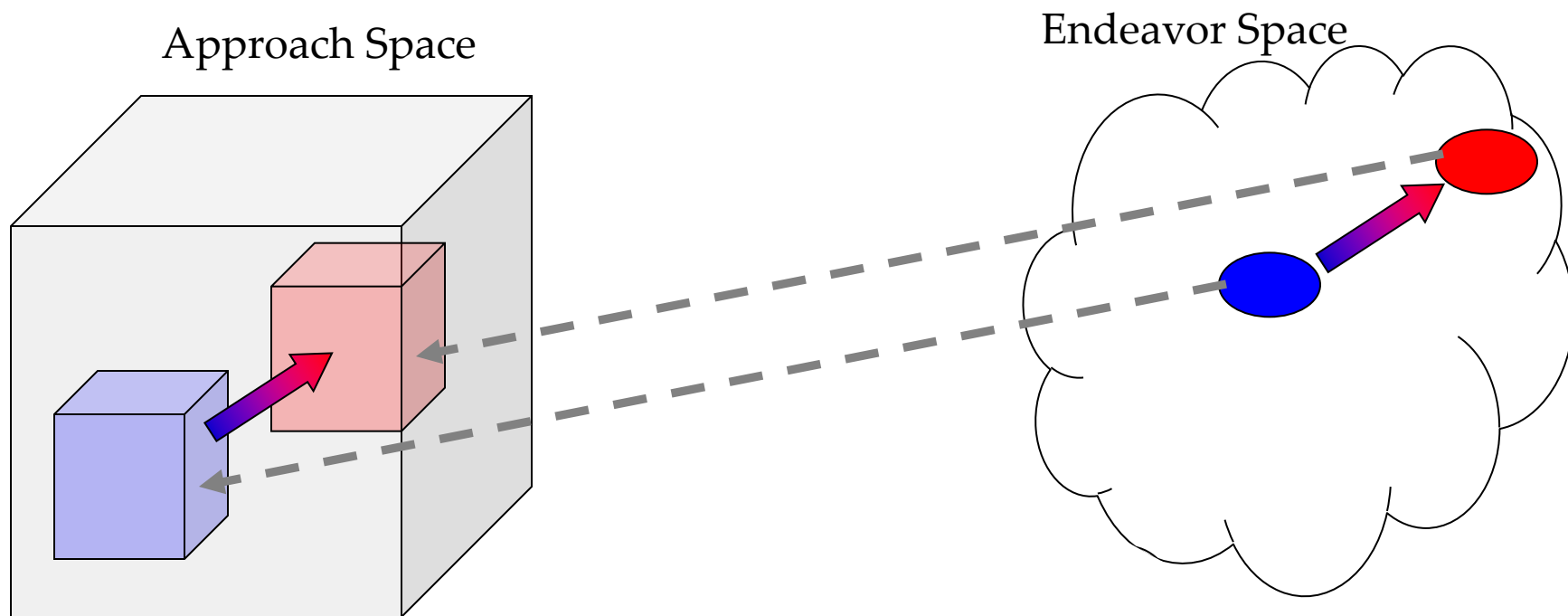
Approach Appropriateness

Endeavor Space

Approach Space
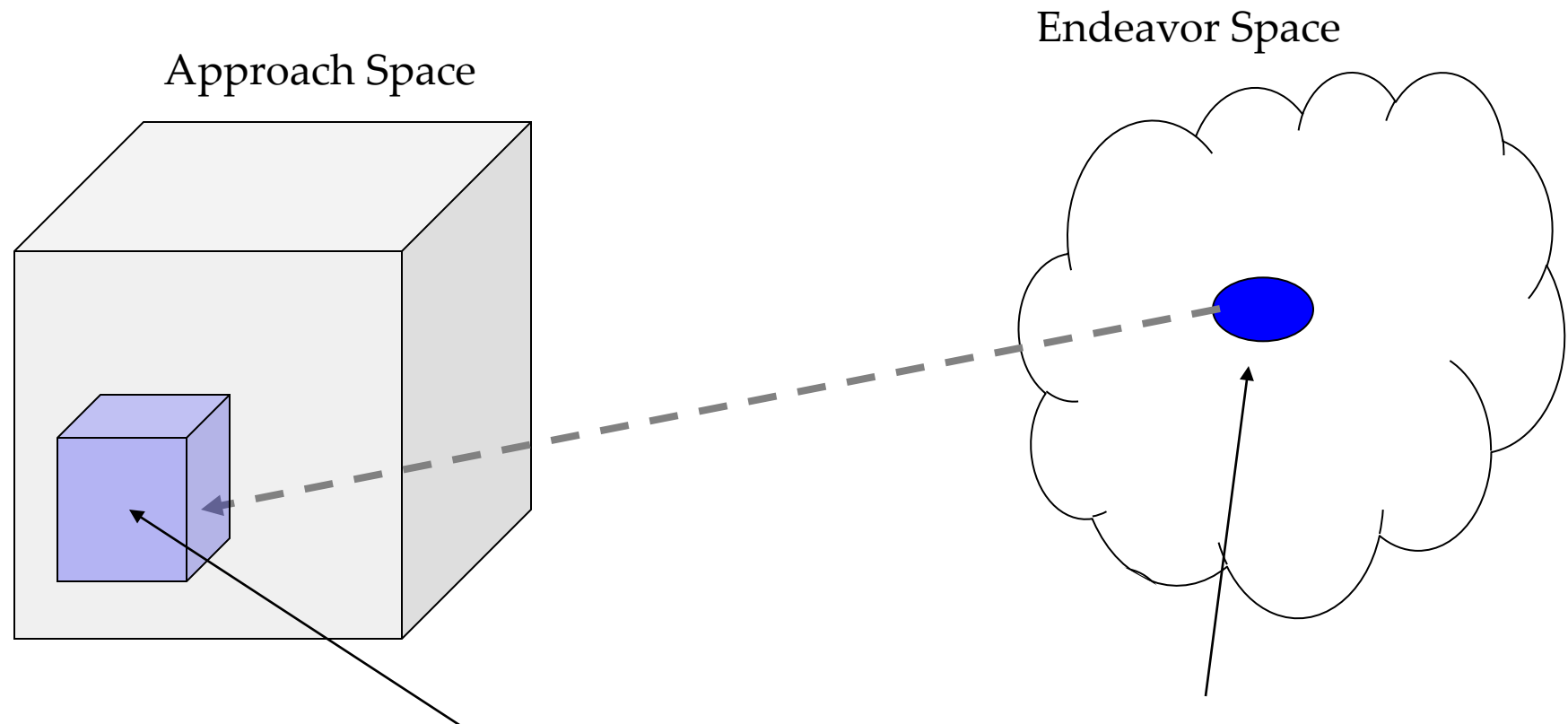
This is a most appropriate Approach for this particular set of circumstances*
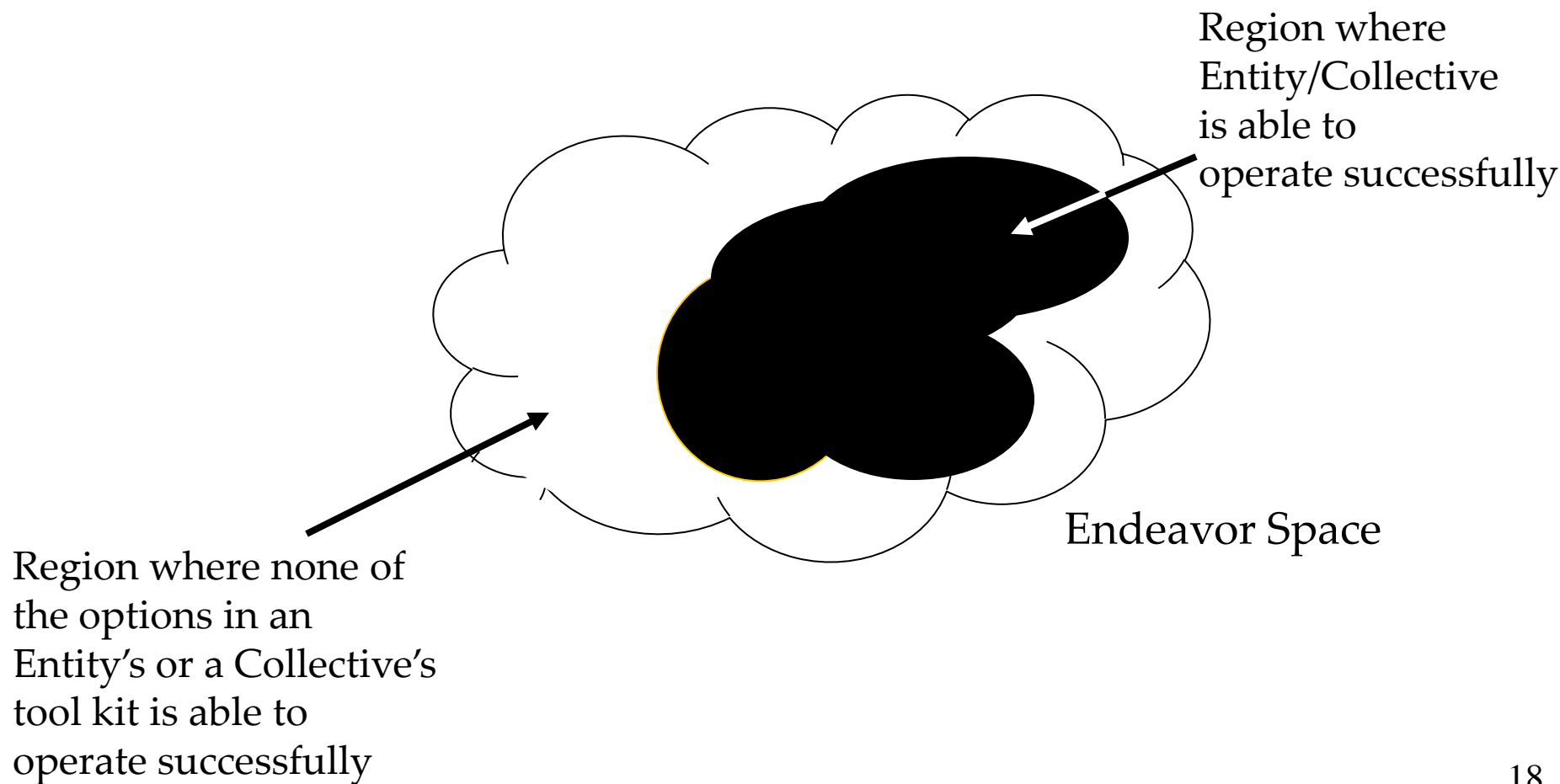
C2/M/G/F&C Agility

When circumstances change, a different Approach may be more appropriate

Approach Space

Endeavor Space

C2/M/G/F&C Agility involves 1) recognizing the significance of a change in circumstances, 2) understanding the most appropriate Approach for the circumstance and 3) being able to transition to this approach.
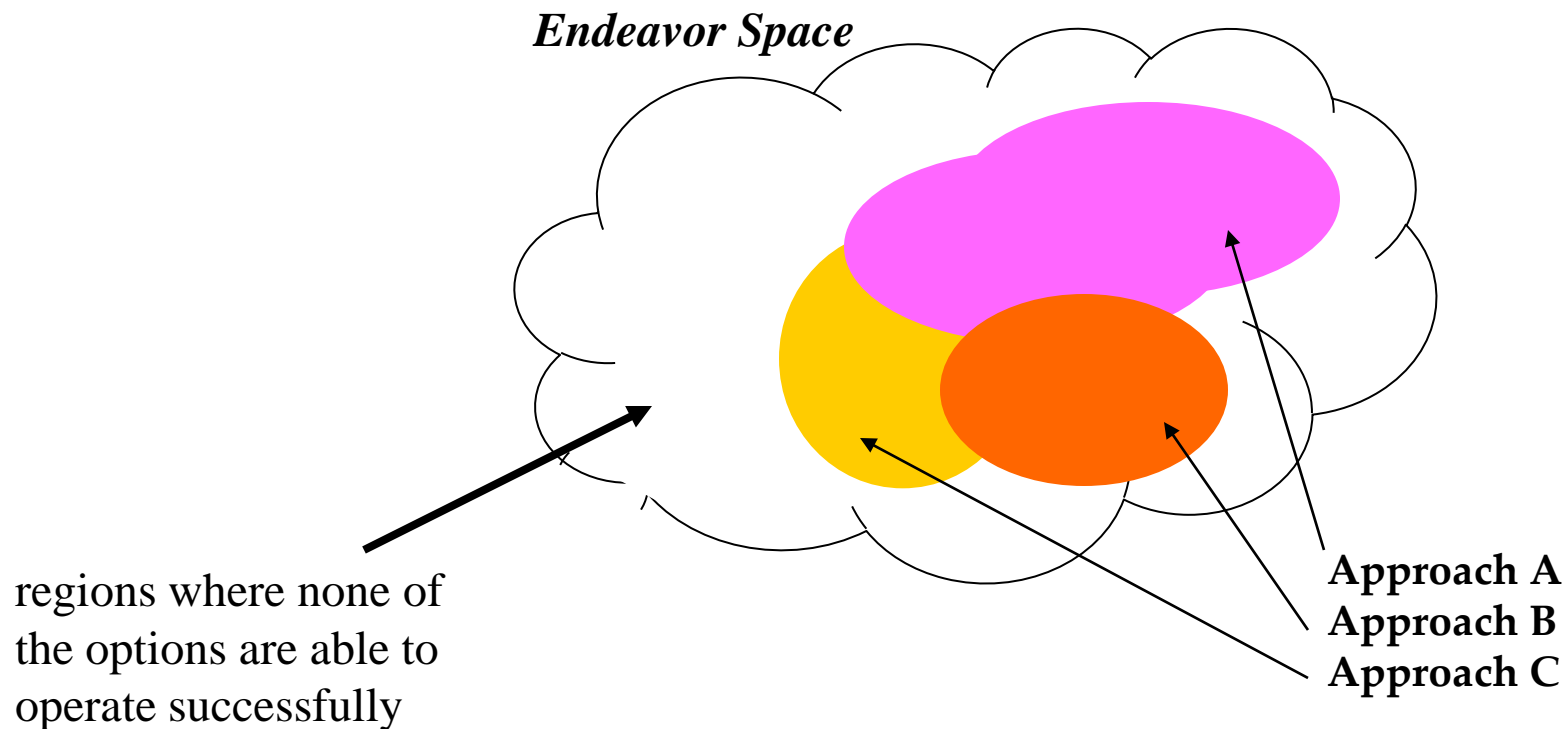
Agility Map

Agility is a function of the Approaches that an Entity/Collective can employ

Region where Entity/Collective is able to operate successfully

Endeavor Space

Region where none of the options in an Entity's or a Collective's tool kit is able to operate successfully

Comparative Agility Map

A Comparative Agility Map shows the most efficient Approach for each region of Endeavor Space

Endeavor Space

regions where none of the options are able to operate successfully

Approach A
Approach B
Approach C

Metrics

- Endeavor Spaces can have a large number of dimensions, making it difficult to visualize and compare Agility Maps.

- Many desire a simple metric. A simple metric may be useful, if it is not misleading.

- Two candidates for a simple Agility metric:

  - % Endeavor Space Covered – the percentage of Endeavor Space where a particular approach or an Entity employing multiple approaches can successfully operate

  - Benchmarked Agility – involves a comparison between projected and expected performance

Agenda

- What do you mean by Agility?

- How does one apply the concept of Agility to C2?

- How can we visualize and measure Agility?

- **Does the evidence support the following assertions?**

  – Different approaches work best in different situations

  – More networked-enabled Approaches are more agile

- Is there a relationship between Cybersecurity and Agility?

Methodology

- Step 1: Define the Endeavor Space and the Approach Options to be considered

- Step 2: Conduct a series of experiments (simulation runs) for each Approach option under each mission-circumstance

- Step 3: Determine values for measures of effectiveness, timeliness and efficiency

- Step 4: Create Agility Maps and calculate values for Agility metrics

Endeavor Space
Dimensions

- Nature of the Mission Challenge
  - 4 Mission Challenges
  - from Industrial Age to Complex Endeavor
- Mission Requirements
  - 3 levels of Shared Awareness (low, medium, high)
  - 3 levels of Timeliness (low, medium, high)
- Signal-Noise in Data
  - 3 levels (no noise, 1/2 noise, 2/3 noise)
- Cognitive Complexity
  - 3 levels (low, medium, high)
- Level of Network Damage
  - 3 levels (none, 1 link down, 2 links down)

972 combinations of mission / conditions

Approach Options

- Hierarchical

- Coordinated

- Collaborative

- Edge

- Post Only Edge

- Edge with Adaptive Information Sharing Policy

Selected Results

- Approach Agility Maps and Metrics

- C2/M/G/F&C Agility Map

- Comparative Advantage Agility Map

- Impact of Adaptive Information Sharing Policy

Hierarchical Approach Agility Map

(low cognitive complexity, no network damage)

■ **Satisfies Conditions**

☐ **Fails to Satisfy**

Complex Endeavor Challenge

Required Shared Understanding — high, med, low

no noise | normal noise | twice the noise

Industrial Age Challenge

Required Shared Understanding — high, med, low

no noise | normal noise | twice the noise

low   med   high
Required Timeliness

Edge Approach Agility Map
(low cognitive complexity, no network damage)

■ **Satisfies Conditions**

☐ **Fails to Satisfy**

Complex Endeavor Challenge

Required Shared Understanding

	no noise		normal noise		twice the noise

Industrial Age Challenge

Required Shared Understanding

	no noise		normal noise		twice the noise

low   med   high
Required Timeliness

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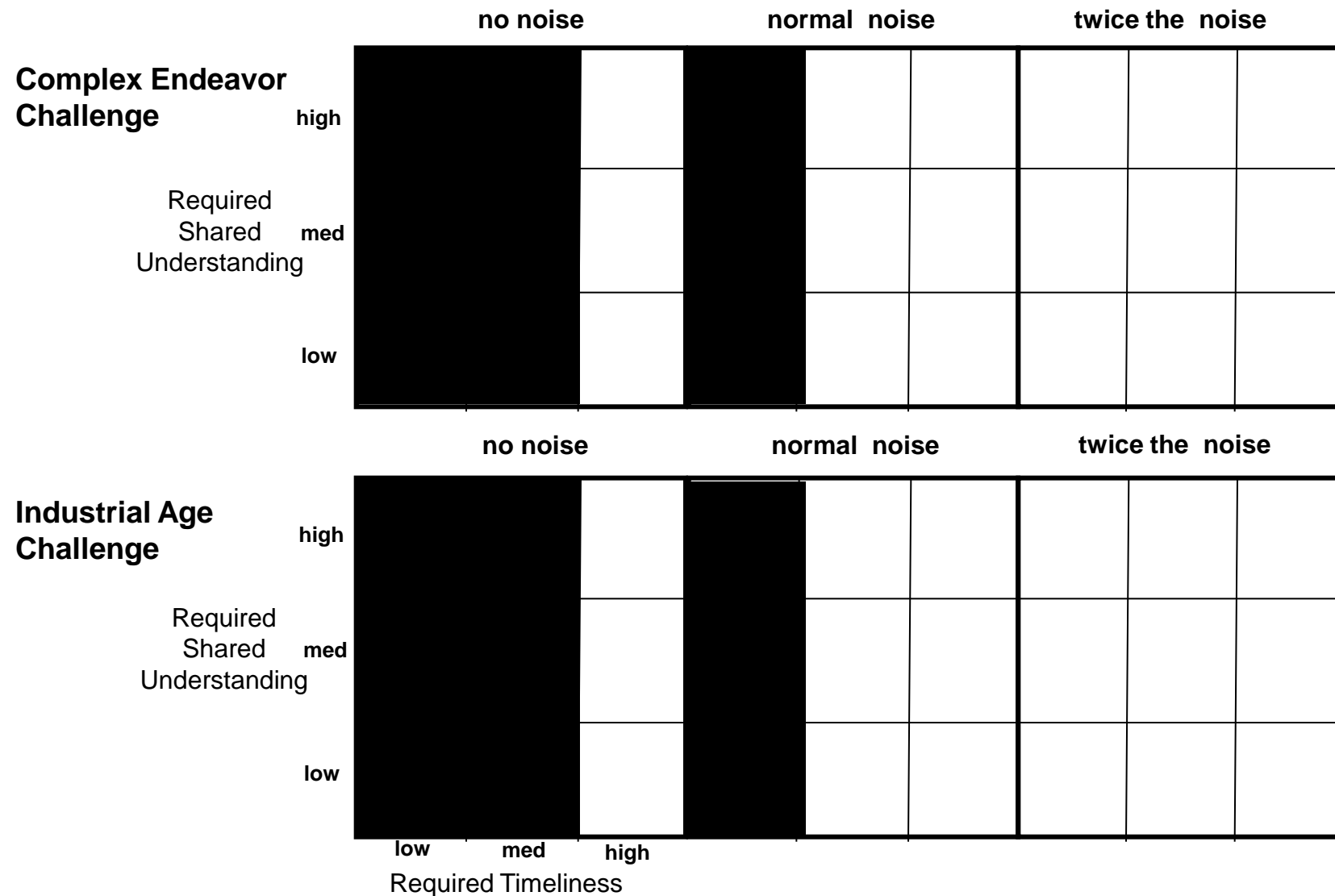
Agility Metrics
as a function of Organization-Approach Option

	Benchmarked Agility Metric (relative to expectations)	Agility Map Coverage (percent Endeavor Space where Entity can operate successfully)
Hierarchy	**16.6%**	**5.5%**
Coordinated	**41.6%**	**9.2%**
Collaborative	**59.7%**	**26.5%**
Edge	**56.5%**	**18.8%**

Agility Map
(low cognitive complexity, no network damage)

Approach Kit = Hierarchical + Collaborative + Edge
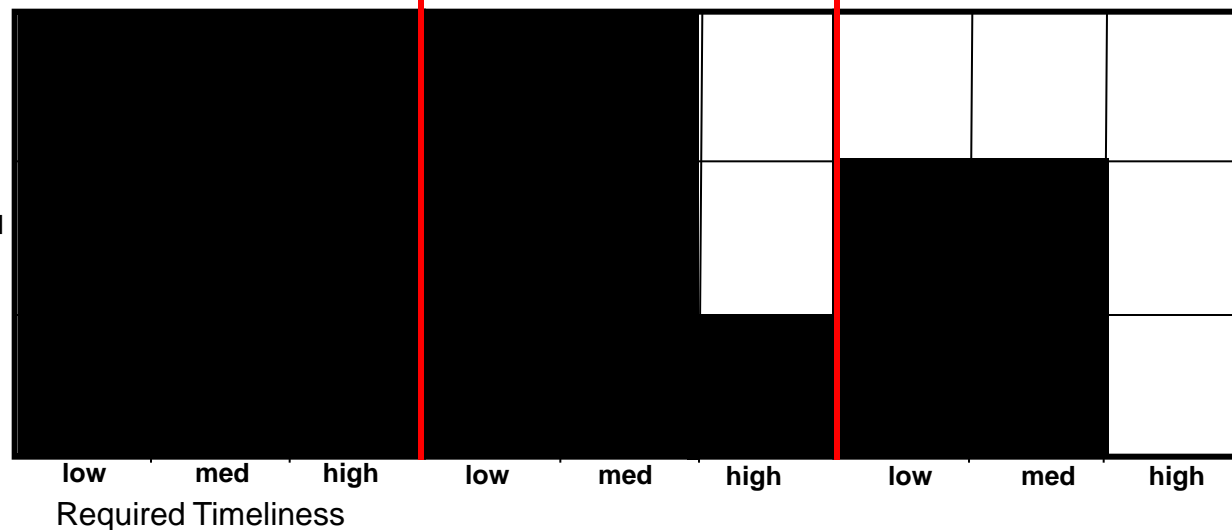
Satisfies Conditions

Fails to Satisfy
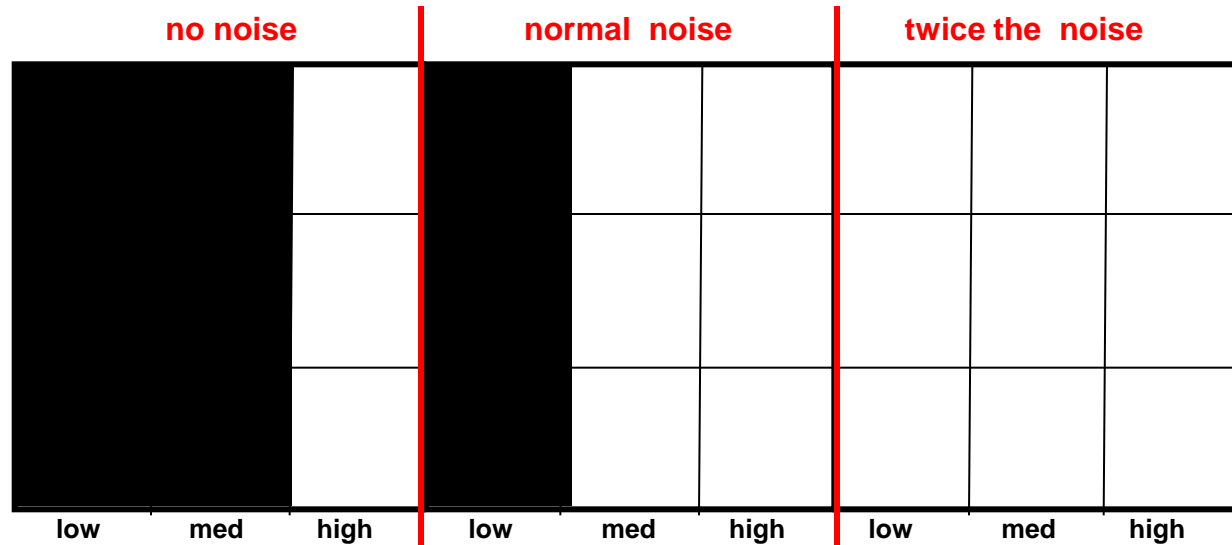
Comparative Agility

as a function of shared understanding, timeliness and noise
cognitive complexity = low; no network damage

Industrial Age Challenge

twice the noise

	low	med	high
high	-	-	-
med	C	C	-
low	C	C	-

Required Speed

Either the only approach that is successful or,
in the case when more than one approach
is successful, the entry is the most efficient one

	low	med	high
high	E	E	-
med	E	C	-
low	E	C	H

Required Speed

no noise

Required Shared Understanding

	low	med	high
high	E	E	E
med	E	E	C
low	E	E	H

Required Speed

E	**Edge**
C	**Collaborative**
C	**Coordinated**
H	**Hierarchy**
-	**None**

Selected Results

- Approach Agility Maps and Metrics

- C2/M/G/F&C Agility Map

- Comparative Advantage Agility Map

- **Impact of Adaptive Information Sharing Policy**

Information Sharing Policy

- The default information sharing policy for all Approach options involves both direct sharing (individual to individual) and web site posting / pulling

- Experiments were conducted with other information sharing policies including "share only" and "post only." These policies remained in effect throughout the runs

- An adaptive information sharing policy was also developed to allow individuals to adapt their behaviors to changed circumstances (e.g. the loss of a web site)

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Impact of
Post Only Information Sharing Policy
on Edge Approach Agility

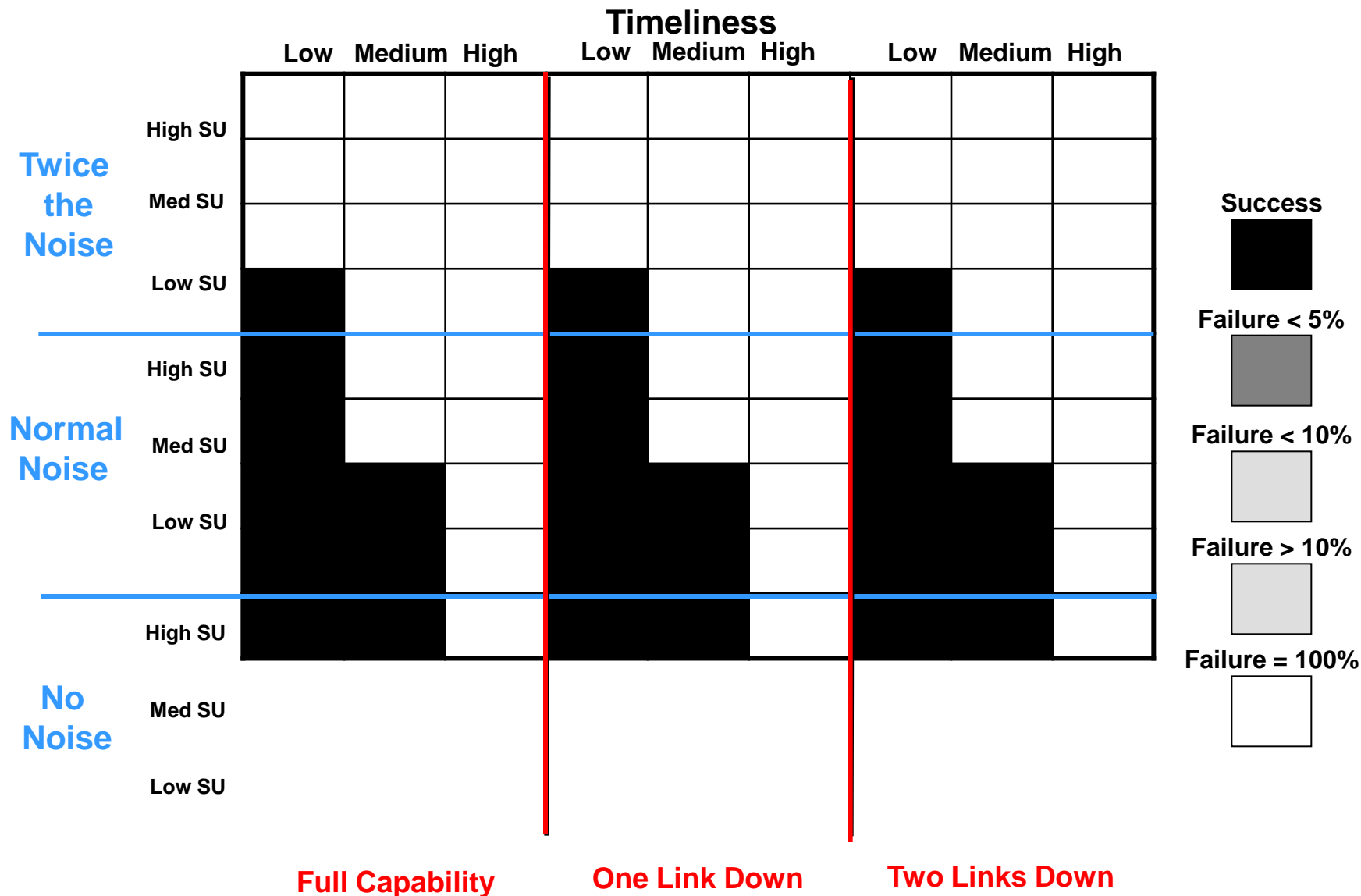|	Benchmarked Agility Metric (relative to expectations)	Agility Map Coverage (percent Endeavor Space where Entity can operate successfully)
Hierarchy	**15.8%**	**5.5%**
Coordinated	**41.0%**	**9.2%**
Collaborative	**59.3%**	**26.5%**
Edge	**56.1%**	**18.8%**
Post Only Edge	**77.1%**	**51.5%**

Impact of
Adaptive Information Sharing Policy
on Edge Approach Agility

- An Edge Approach is well suited to situations, but does not perform well work load exceeds a certain threshold (e.g. noise conditions are high)

- A Post Only Edge out performs the Edge when noise conditions are high but is vulnerable to network damage

- A Edge that can adopt its information sharing behaviors to suit the conditions combines the best of both approaches

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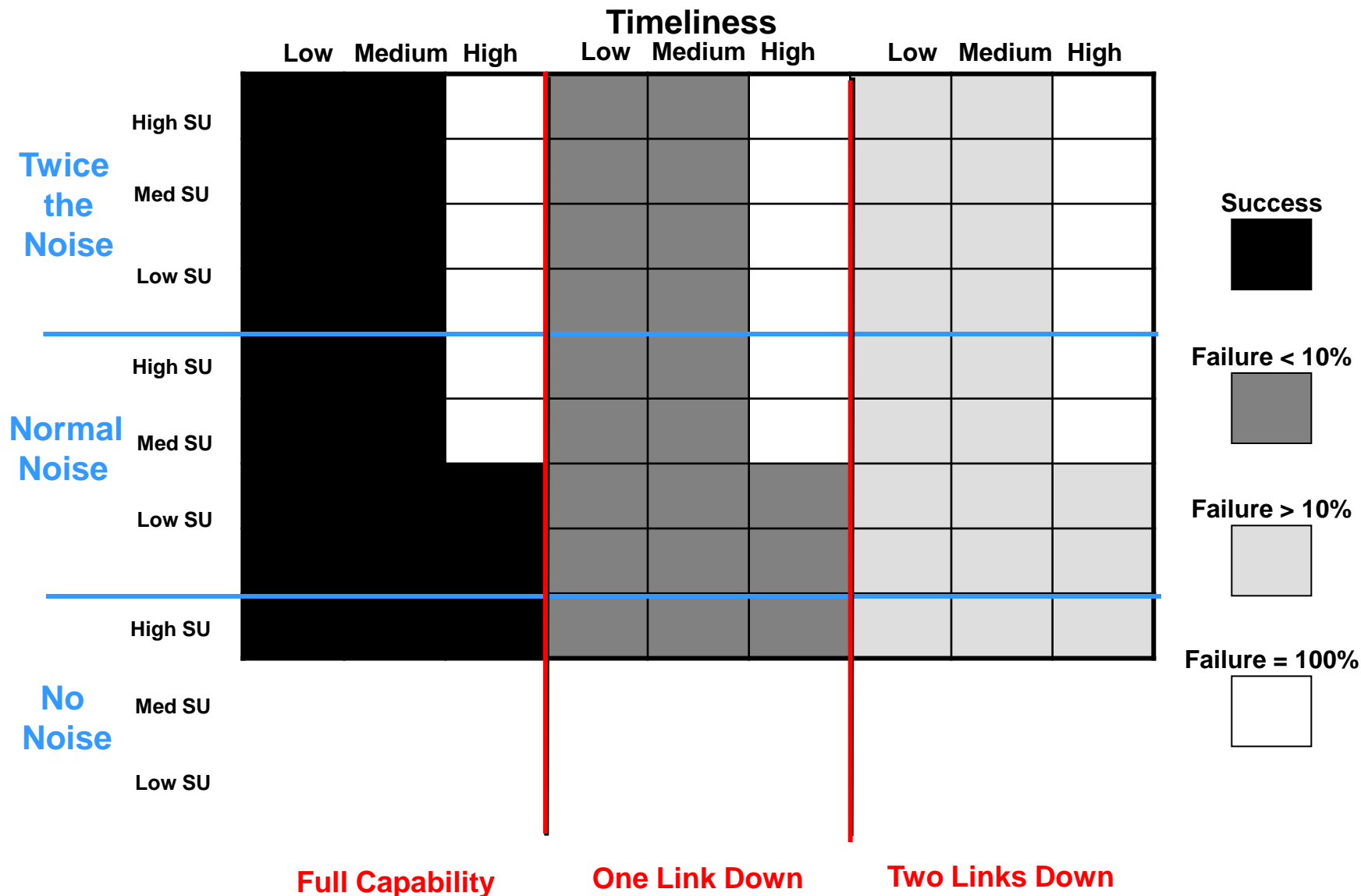# Edge Approach Agility Map
Industrial Age Challenge
Under Varying Noise and Sustained Network Damage

Post Only Edge Approach Agility Map
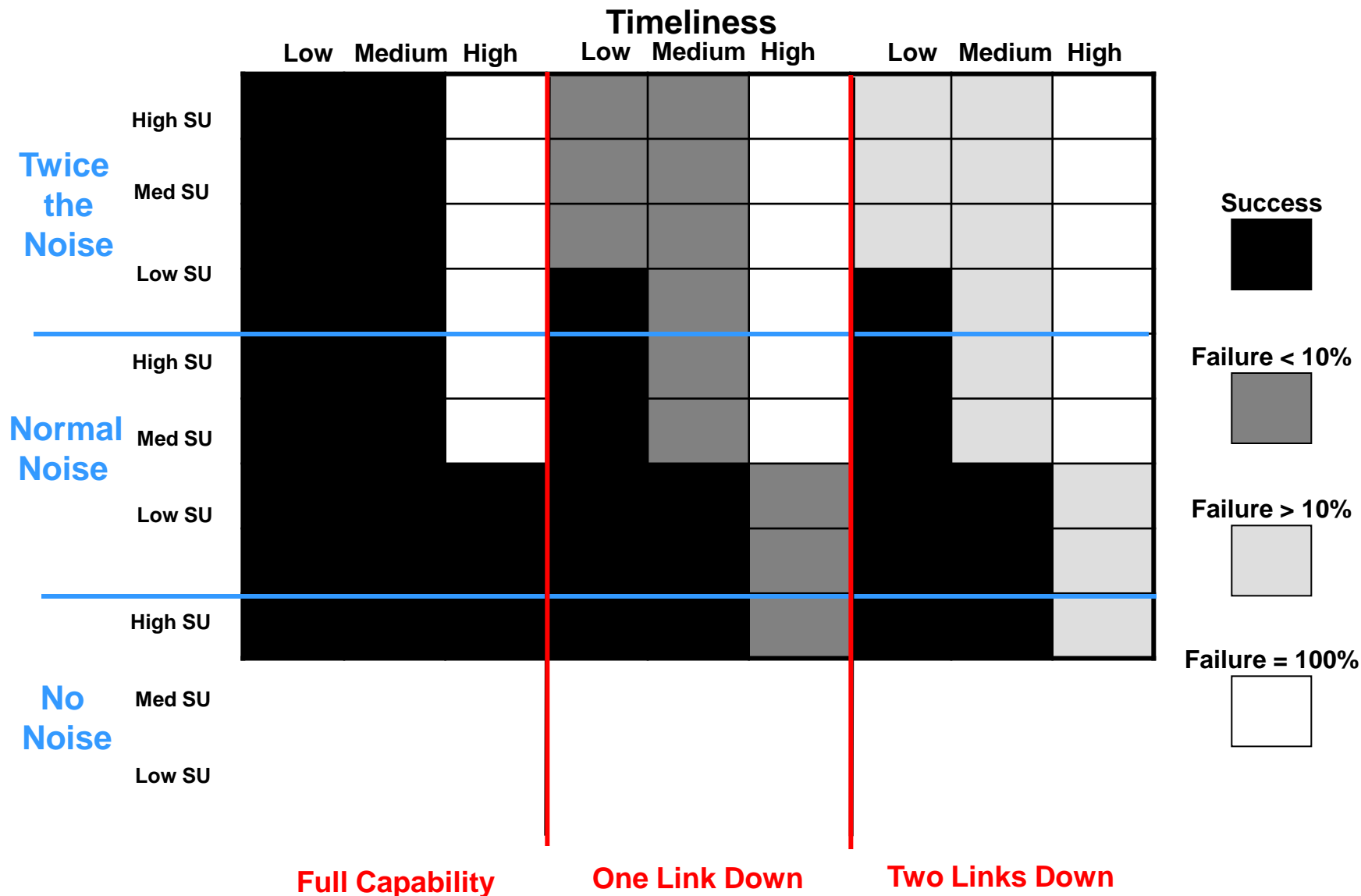# Industrial Age Challenge
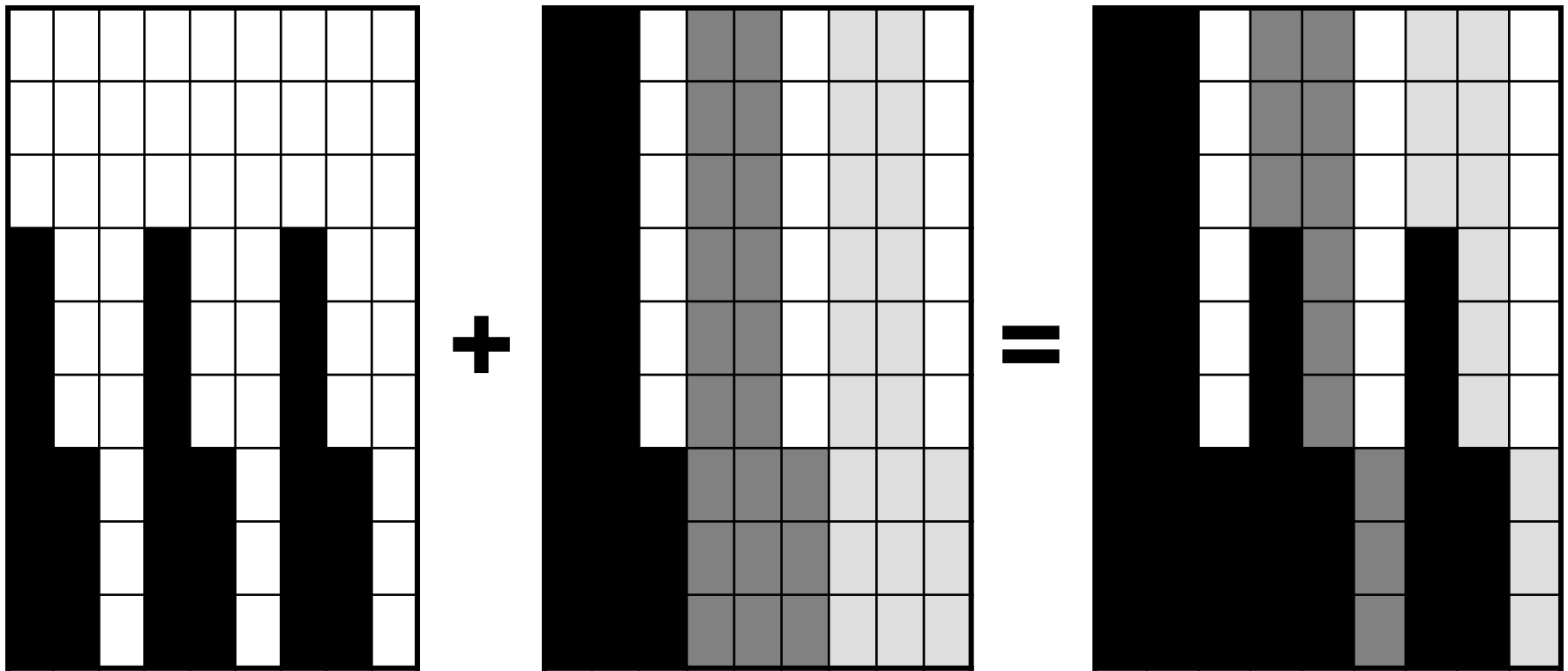## Under Varying Noise and Sustained Network Damage

Edge Approach with an Adaptive Policy
Industrial Age Challenge
Under Varying Noise and Sustained Network Damage

Impact of an Adaptive Policy

Impact of Adaptive Policy

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Edge	**56.1%**	**18.8%**
Post Only Edge	**77.1%**	**51.5%**
Adaptive Edge	**78.1%**	**53.0%**

Simple metrics can be misleading!

Findings and Conclusions

- Agility can be depicted and measured; simple metrics must be used with caution

- No Approach is best in all circumstances

- Network-enabled Approaches have the potential to be more agile

- Adaptive information sharing policies enhance Agility

- Being able to employ multiple Approaches enhances Entity or Collective Agility

- Cybersecurity and Agility are related

- Formulating the Endeavor Space appropriately is, perhaps, the most challenging aspect of Agility-related analysis

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Questions ?